PLANT IS MAJOR FOR NO_x OR CO, OR HEATER HAS A NSR LIMIT FOR NO_x OR CO

OPERATING SITUATION	THE HEATER HAS A ER[1] ≥ 100 TPY NO_X OR CO AND PLANT IS IN A SENSITIVE AREA[2] **OR** HEATER ER. ≥ 250 TPY CO OR NO_X ANYWHERE IN NM	THE HEATER HAS A ER[1] ≥ 100 TPY NO_X OR CO BUT < 250 TPY **AND** PLANT IS **NOT** LOCATED IN A SENSITIVE AREA[2]	THE HEATER HAS A ER[1] ≥ 25 TPY NO_X OR CO BUT < 100 TPY	THE HEATER HAS A ER[1] ≥ 1 TPY NO_X OR CO BUT < 25 TPY (see note #6)
EQUIPMENT INSPECTION				
OPERATIONAL INSPECTION	VISUAL INSPECTION OF FLAME AND COMBUSTION ZONE FOR SIGNS OF INSUFFICIENT OR TOO MUCH EXCESS AIR: FLAME COLOR, BURNER PULSATIONS, ROAR, SOOT DEPOSITS, SMOKE, ETC.			
SAMPLING FOR EXCESS AIR	SAMPLING OF STACK GAS FOR CONCENTRATION OF O_2 USING A PORTABLE O_2 SENSOR OR ORSAT ANALYZER[7]			
MASS EMISSIONS TEST	SAMPLING OF STACK GASES FOR: NO_X, CO, AND O_2 USING PORTABLE ANALYZER; FLOW RATE USING PITOT TRAVERSE, F-FACTOR OR EQUIVALENT			
MONITORING FREQUENCY	OPERATIONAL INSPECTION: WEEKLY EXCESS AIR CHECK: WEEKLY MASS EMISSIONS TEST: AT 90 DAYS, ANNUALLY THEREAFTER	OPERATIONAL INSPECTION: WEEKLY EXCESS AIR CHECK: MONTHLY	OPERATIONAL INSPECTION: MONTHLY EXCESS AIR CHECK: SEMIANNUAL	OPERATIONAL INSPECTION: ANNUAL
EPA METHOD TEST[3]		FULL EPA METHODS TEST WITHIN 180 DAYS OF PERMIT ISSUANCE[4]		

NOTE: If the emission unit is a boiler (steam generating unit) and NSPS applies under 40CFR60 Subpart D, Da, Db, or Dc, then the permit engineer must consider if the monitoring in this protocol is needed.

PLANT IS MAJOR FOR NO_x OR CO, OR HEATER HAS A NSR LIMIT FOR NO_x OR CO

OPERATING SITUATION	NON GASEOUS FUELS (oil, etc.)	THE HEATER IS PERMITTED BELOW ITS FULL ER. AND THE ER.[1] IS ≥ 25 TPY NO_X OR CO	THE HEATER HAS A ER[1] ≥ 25 TPY NO_X OR CO AND HAS HAD NO FULL EPA TEST IN THE 10 YEARS PREVIOUS TO PERMIT ISSUE
OPACITY MEASUREMENTS	MEASURE OPACITY ACCORDING TO 40 CFR 60, METHOD 9		
FUEL USAGE		CONTINOUS MEASUREMENT OF FUEL CONSUMPTION IN DAILY AVERAGE MMBTU/HOUR	
EQUIPMENT INSPECTION		SEE NOTE 5	SEE NOTE 5
OPERATIONAL INSPECTION		SEE NOTE 5	SEE NOTE 5
SAMPLING FOR EXCESS AIR		SEE NOTE 5	SEE NOTE 5
MASS EMISSIONS TEST		SEE NOTE 5	SEE NOTE 5
MONITORING FREQUENCY	OPACITY MEASUREMENTS: AT 90 DAYS, ANNUALLY THEREAFTER	CONTINOUS MEASUREMENT OF FUEL FLOW. IF GAS IS NOT PIPELINE QUALITY, MONTHLY MEASUREMENT OF HEATING VALUE. ALSO SEE NOTE 5.	SEE NOTE 5
EPA METHODS TEST[3]			FULL EPA METHODS TEST WITHIN 180 DAYS OF PERMIT ISSUANCE[4]

NOTE: If the emission unit is a boiler (steam generating unit) and NSPS applies under 40CFR60 Subpart D, Da, Db, or Dc, then the permit engineer must consider if the monitoring in this protocol is needed.

NOTES:

The purpose of this protocol is to determine monitoring requirements for emissions. Operational constraints are monitored by imposing record keeping requirements or other appropriate means.

1. ER. = Emission Rate means the emission rate of a heater at its maximum capacity to emit in the absence of air pollution control equipment which is not vital to its normal operation. If a unit has a permit condition limiting hours of operation or imposing another operational/physical limit, then these limits are included in determining ER.

. For purposes of this document, a staged combustion LO-NOx burner is not considered a control, but flue gas recirculation, due to the adjustable nature of the recirculation, is considered a control. If a unit has a permit condition limiting hours of operation or imposing another operational physical limit, the permit needs to impose monitoring to ensure compliance with that condition. (see the leftmost column on page 2.)

2. A sensitive area is a) a designated restricted area for streamline permits; b) the plant location for a plant whose NOx emissions exceed 80% of the NAAQS, excluding background concentrations from other plants, c) a non-attainment area for NOx, Ozone, or CO.

3. For multiple units of the same make and model, at least 50% must be tested. Other units must at least have their excess combustion air measured. Inconsistent test results may cause all remaining units to be tested. All units must be tested if plant is located in a sensitive area.

4. EPA Method test waived if full EPA test acceptable to the Department has been carried out in the five (5) years previous to permit issue.

5. See appropriate monitoring in another category on this page or previous page if that category also pertains to the heater.

6. If NOx or CO emission rate is < 1 tpy and has a NSR emission limit, then identify the unit and the emission limit in the permit, but monitoring is not needed.

7. Boilers/heaters with CEMS (continuous emissions monitoring system) are not required to manually undergo excess air checks since these systems already measure O_2 concentration.

MONITORING PROTOCOL
GAS-FIRED HEATERS, FURNACES AND BOILERS
AT NEW MEXICO TITLE V SOURCES

December update: revised Section 5.3 to match word template, deleted all tabs, and changed to block format.

Purpose. These guidelines are intended to help Title V permit engineers include adequate periodic monitoring conditions into operating permits in accordance with 20.2.70 NMAC, sections 302.C, 302.D, and 302.E. These guidelines also help ensure consistency in monitoring conditions for all operating permits regardless of the engineer assigned to the permit. **If the emission unit is a boiler (steam generator as defined by NSPS), and is an affected facility under 40 CFR 60 Subpart D, Da, Db, or Dc, the permit engineer must consider if the monitoring in this protocol is necessary.**

Permit Language.

3.4 Emission Monitoring and Testing Requirements. These conditions are included pursuant to 20.2.70.302.C [AC [jwk1]**{and NSR permit no. XXX.}**

3.4.1 The following table lists emission units and their applicable requirements and required monitoring. Descriptions of required monitoring follow the table:

Emission Unit Nos.	Parameters to Monitor	To Comply With:	Monitoring Required	Monitoring Frequency
Heaters X...Z	Flame characteristics	Emissions limits specified in Section 3.X	Operational inspection	Weekly
	Excess Air	Emissions limits specified in Section 3.X	Flue gas analysis	Monthly
etc.	etc.	etc.	etc.	etc. .....

{Apply the following sections heater by heater as required by the diagrams on pages 1 and 2.}
NOTE: Equipment inspection has been deleted from the monitoring protocol.

3.4.1.X Operational Inspection (For Boilers and Heaters): The heaters listed in Sect. 3.4.1 shall undergo operational inspections **(insert frequency here)** by the methods described below:

The permittee shall conduct operational inspections of the heater to determine that the heater is operating properly. The operational inspections shall include operational checks for indications of insufficient excess air, or too much excess combustion air. These operational checks shall include observation of common physical indications of improper combustion, including indications specified by the heater manufacturer, and indications based on operational experience with these units.

3.4.1.X Monitoring of Excess Air (For Boilers and Heaters): The heaters listed in Sect. 3.4.1 shall have the excess air level in the flue gas measured at the frequency indicated in the table using a portable oxygen analyzer, an ORSAT analyzer, or other method approved in advance by the Department. If an ORSAT apparatus or other gas absorption analyzer is used, the permittee must follow the procedures described in Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, US EPA, Publication no. EPA-600/4-77-02 (or later), Section 3.2.

Excess air measurements that use an electronic analyzer must conform to the procedures in the most current version of the Bureau's Standard Operating Procedure: Use of Portable Analyzers in Performance Tests. The permittee need only observe the steps that: a) require submission of a protocol, b) specify a minimum instrument response time, c) require instrument calibration, and d) specify the method of sampling the flue gas. The permittee shall carry out a minimum of five minutes of uninterrupted sampling for each stack.

Each measurement shall be conducted at 90% or greater of full normal load as stated in this permit, or in the permit application if not in the permit, and at additional loads when requested by the Department. If the 90% load cannot be achieved, these tests may be conducted at the maximum achievable load under prevailing operating conditions[jwk2]. The load and the parameters used to calculate it shall be recorded to document operating conditions and shall be included with the test report that is required to be furnished to the Department.

3.4.1.X Monitoring of Fuel Usage (For Boilers and Heaters): Fuel usage shall be measured on the heaters listed in Sect. 3.X.1 at the frequency indicated in the table by the methods described below.

The fuel flow rate shall be determined using a properly calibrated fuel flow meter. The daily fuel flow shall be displayed on an appropriate chart or on an electronic totalizer. The fuel flow rate shall be measured on a scale such that the flow rate is between 20% and 80% of the meter's full scale. One fuel meter shall be used per heater.

3.4.1.X Periodic Mass Emission Tests (For Boilers and Heaters): Periodic mass emission tests shall be carried out on the heaters listed in Section 3.4.1 for NO_x and CO at the intervals in the following schedule:

First Test --- six (6) months of permit issuance.
Second Test --twelve (12) months of permit issuance.
All subsequent testing shall be done annually.

All subsequent testing shall follow at annual intervals. This test schedule is contingent on maintaining test data, which indicates compliance. If at any test the test data indicate non-compliance, the periodic emissions test sequence shall revert to the beginning of the above schedule starting with the date of the most recent test. **{If facility is major for VOCs or NSR permit has VOC emission limits, then include following.}** Test results that demonstrate compliance with the NO_x and CO emission limits shall also be considered to demonstrate compliance with the VOC emission limits.

3.4.1.X EPA Method t [jwk3](For Boilers and Heaters): An EPA Method test shall be performed

on the heater/boiler for unit numbers **(insert unit numbers here)** within six (6) months of permit issuance, using EPA reference test methods in 40 CFR 60.

Emission testing is required for NO_x and CO. **{If facility is major for VOCs or NSR permit has VOC emission limits, then include following.}** Test results that demonstrate compliance with the NO_x and CO emission limits shall also be considered to demonstrate compliance with the VOC emission limits.

3.4.1.X Opacity Monitoring (For Units ***x, y, x***): **{When required}** Use of pipeline quality [njj4]natural gas fuel constitutes compliance with opacity requirements. At such time as fuel other than pipeline quality natural gas is used opacity shall be measured in accordance with the procedures at 40CFR60, Appendix A, Method 9. Opacity measurements shall continue on a quarterly basis until such time as pipeline quality natural gas is used. **{If required: This condition was brought forward from NSR Permit XXX-MX4, Condition X.} {or adjust schedule as required on a case by case basis}**

3.4.2 Test Methods and Procedures **{When required}**

3.4.2.1 Periodic Mass Emissions Test (For Boilers and Heaters):

3.4.2.1.1 Heaters shall be tested in the "as found" condition. Heaters may not be adjusted prior to any test for the purpose of lowering emissions, and then returned to previous settings or operating conditions after the test is complete.

3.4.2.1.2 Mass emissions rates of NO_x and CO may be carried out using a portable flue gas analyzer using the procedures in the most current version of the Bureau's Standard Operating Procedure: Use of Portable Analyzers in Performance Tests. The test may also be carried out using any method approved in advance by the Department.

3.4.2.1.3 The fuel flow rate shall be measured during the test and shall be determined using a properly calibrated fuel flow meter. The fuel flow rate shall be measured on a scale such that all flow rates are between 20% and 80% of the meter's full scale.

3.4.2.1.4 Three test runs shall be conducted at 90% or greater of the full normal load as stated in this permit, or in the permit application if not in the permit, and at additional loads when requested by the Department. If the 90% load cannot be achieved, these tests may be conducted at the maximum achievable load under prevailing operating conditions[njj5]. The load and the parameters used to calculate it shall be recorded to document operating conditions and shall be included with the test report that is required to be furnished to the Department.

3.4.2.1.5 If a test shows that the heater fails to meet an emissions limit, the mass emissions testing schedule shall revert to the starting schedule. The reference date shall be the date of the most recent test instead of the date of permit issue.

3.4.2.2 EPA Methods Test (For Boilers and Heaters): The following analysis procedures and test methods shall be performed as part of the EPA Methods test requirement for the heaters listed in Sect. 3.4.1.

3.4.2.2.1 The heater tests shall be conducted in accordance with EPA Methods 1 through 4, 6 for (SO_2), 7 for (NO_x) and 10 for (CO) contained in 40 CFR Part 60, Appendix A, and with the requirements of Subpart A, General Provisions, Sect. 60.8(f). The results of the test for nitrogen oxides shall be expressed as nitrogen dioxide (NO_2) using a molecular weight of 46 lb/lb-mole in all calculations (each ppm of NO/NO_2 is equivalent to $1.194x10^{-7}$ lb/scf).

3.4.2.2.2 The permittee shall notify the Department at least thirty (30) days prior to the test date and allow a representative of the Department to be present at the test. The permittee shall arrange a pre-test meeting with the Department at least thirty (30) days prior to the test date and shall observe the following pre-testing and testing procedures:

a) The test protocol and test report shall conform to the standard format specified by the Department. The most current version of the format may be obtained from the Enforcement Section of the Air Quality Bureau.

b) The permittee shall provide (a) sampling ports adequate for the test methods applicable to the facility, (b) safe sampling platforms, (c) safe access to sampling platforms and (d) utilities for sampling and testing equipment. The stack shall be of sufficient height and diameter so that a representative test of the emissions can be performed in accordance with EPA Method 1.

c) During emission tests, the heater's fuel consumption rate shall be measured continuously and recorded at least once every five minutes. If the fuel gas is other than pipeline quality natural gas, the heat content of the fuel gas shall be determined from a fuel sample obtained within 24 hours of the test. The firebox temperature shall be measured and recorded at least once every 30 minutes. This information shall be included with the test report that is required to be furnished to the Department and shall be listed in tabular form or as part of the summary page of the test report.

d) Where necessary to prevent cyclonic flow in the stack, flow straighteners shall be installed.

e) The test shall be conducted at 90% or greater of full normal load as stated in this permit, or in the permit application if not in the permit, and at additional loads when requested by the Department. If the 90% load cannot be achieved, these tests may be conducted at the maximum achievable load under prevailing operating conditions[1]. The load and the parameters used to calculate it shall be recorded to document operating conditions and shall be included with the test report that is required to be furnished to the Department.

3.4.3 When requested by the Department, the permittee shall provide schedules of testing and monitoring activities.

3.4.4 Unless otherwise identified elsewhere in this permit, all monitoring requirements are effective 120 days after the date of permit issuance.

RECORDKEEPING

4.1.2 The permittee shall maintain records of all heater inspections and tests required by this permit and records of any adjustments, repairs, or replacements needed to bring the heater into compliance or

that affect excess combustion air. Records shall clearly identify the heater, note the heater's location within the plant, the heater's ID number according to the operating permit, and the ID number according to plant records if different.

The permittee shall also follow the recordkeeping requirements listed below and shall record any other information the Department may need to verify the accuracy of the monitoring.

4.1.2.1 Operational Inspection (For Boilers and Heaters): Records of operational inspections shall describe the results of visual and other sensory observations for insufficient or excessive combustion air in accordance with Section 3.4.1.X. The permittee shall also note the type of fuel fired (pipeline quality natural gas, field gas, etc.), and append a contemporaneous fuel analysis if the gas is other than pipeline quality natural gas.

4.1.2.2 Monitoring of Excess Air (For Boilers and Heaters): Records of monitoring of excess combustion air shall include the heater's fuel flow rate and firing box temperature. If an electronic O_2 sensor is used, records shall be kept of instrument calibration data, and the make and model of the instrument. If an ORSAT apparatus or other gas absorption analyzer is used, the permittee must record all calibration results.

4.1.2.3 Monitoring of Fuel Usage (For Boilers and Heaters): Records of fuel usage shall include the make and model of the fuel flow meter, all charts generated by the flow meter, the type of fuel fired (pipeline quality natural gas, field gas, etc.), a contemporaneous fuel analysis if the gas is other than pipeline quality natural gas, and all instrument calibrations. The record shall include a flow diagram showing the configuration of the flow meter relative to the heater.

4.1.2.4 Periodic Mass Emission Tests (For Boilers and Heaters): Records of periodic mass emission tests shall include the heater's fuel flow rate, the firing box temperature, the type of fuel fired (pipeline quality natural gas, field gas, etc.), and a contemporaneous fuel analysis if the gas is other than pipeline quality natural gas. If a combustion analyzer is used to measure NO_x, CO, and/or excess air in the flue gas, records shall be kept of the make and model of the instrument and instrument calibration data. If an ORSAT apparatus or other gas absorption analyzer is used, the permittee shall record all calibration results.

Records shall be kept of all raw data used to determine flue gas flow and of all calculations used to determine flow rates and mass emission rates.

4.1.2.5 Opacity Recordkeeping (For Units ***x, y, x***): The permittee shall record dates and duration of use of any fuel other than pipeline quality natural gas and the corresponding opacity measurements.

REPORTING

5.0 REPORTING

5.1 Monitoring Reports. Monitoring reports shall clearly identify the subject heater showing the heater's number according to the operating permit.

All instances of deviations from permit requirements, including those that occur during emergencies,

shall be clearly identified in the required reports. Conditions of Section 5.1 are included pursuant to 20.2.70.302.E NMAC.

5.1.1 Operational Inspections, and Excess Air Measurements (For Boilers and Heaters): Reports of operational inspections and excess air measurements shall briefly summarize in chronological order the results of all heater inspections noting any adjustments needed to bring the heater into compliance with permit conditions.

5.1.2 Monitoring of Fuel Usage (For Boilers and Heaters): Fuel usage reports shall show the average amount of fuel consumed by each affected heater for every calendar month expressed in MMBTU/hour.

5.1.3 Periodic Mass Emission Tests (For Boilers and Heaters): Reports of periodic mass emission tests shall summarize in tabular form for each test the **{CO, NO_x, SO_2, as appropriate}** mass emissions rates expressed in pounds per hour. The table shall include the average concentration of all relevant pollutant species, the gas flow rate, the stack gas temperature, the level of excess air, and the percent moisture.

5.1.4 EPA Method Test (For Boilers and Heaters): The report of the initial or subsequent emission test shall summarize in tabular form for each test the **{CO, NO_x, SO_2, as appropriate}** mass emissions rates expressed in pounds per hour. The table shall include the average concentration of all relevant pollutant species, the gas flow rate, the stack gas temperature, the level of excess air, and the percent moisture.

5.1.5 Opacity Reporting (For Units ***X, Y, Z***): The permittee shall report dates and duration of use of any fuel other than pipeline quality natural gas and the corresponding opacity measurements. **[If units burn diesel fuel, certification of grade and characteristics as stated in permit application for fuel used during the period shall be reported.]**

5.2 Reporting Frequency. **(See Permit Template language)**

5.3 Submission of Test Protocol. Protocols for emissions tests shall be submitted to the Department at least thirty (30) days [k7]prior to the scheduled test date. Content of the test protocols shall be reported according to the Department's Standard Operating Procedure for Contents of Stack Test Protocols. If information remains the same as previously submitted protocols, test protocols shall reflect that fact and show only new information. This condition is pursuant to 20.2.70.302.E NMAC.

5.4 Within ninety (90) days of permit issuance, the permittee shall submit for Department approval a procedure which the permittee will use to carry out the operational inspection required by Sect. 3.X.X.X of this permit. The permittee may at any time submit revisions for Department approval. Condition 5.4 is pursuant to 20.2.70.302.E NMAC.

BACKGROUND INFORMATION

(Not for inclusion in permit)

In New Mexico, most industrial heaters, boilers, and furnaces[1] are found at oil and gas processing plants. Some heaters can be found at compressor stations but these are used for dehydration and tend to be small. Industrial size heaters can also be found at manufacturing plants, such as Intel, but due to our state's small industrial base, there are few manufacturing plants large enough to require large heaters. Most gas-burning heaters burn sweet natural gas (i.e. <10 ppm H_2S) except heaters at refineries which often burn refinery fuel consisting of hydrogen/methane/ethane with as much as 160 ppm H_2S.

Character of Emissions. Emissions from natural gas fired heaters consist almost exclusively of NO_x and CO. Emissions of particulates, sulfur oxides, and VOCs tend to be negligible compared to emissions of NO_x and CO and will not be considered in this document. SO_2 is only of concern at heaters located in refineries when refinery fuel gas is burned. But even here, SO_2 emissions are usually monitored by an H_2S fuel-line CEM required by NSPS Subpart J. Of the four refineries in the state, only the Artesia refinery is known to burn refinery fuel gas.

As with all combustion sources, the minimum emissions of NO_x, the minimum emissions of CO, and the heater's overall thermal efficiency occur at different operational settings. The operator is therefore faced with tradeoffs that inevitably result in a set of emissions levels and a thermal efficiency that, although not optimal for either, result in satisfactory operation of the heater and result in emissions levels that are within the permitted values.

NO_x Formation. Almost all NO_x from natural gas fired heaters is thermal NO_x. Fuel bound NO_x and prompt[2] NO_x account for negligible amounts of pollutant. NO_x emissions are of primary concern due to the state's restrictive 24-hour ambient standard for NO_x. It is uncommon for CO emissions from a heater to threaten ambient standards, although a unit operated at too low a value of excess air (less than about 1%) can inadvertently cause the CO emissions to rise dramatically.

Not only do the operating conditions determine the NO_x and CO emissions levels, but the design of the combustion chamber also affects the emissions.

Burner design strategies used to minimize NO_x. Lo-NO_x heaters, known more appropriately as staged combustion heaters, succeed in reducing NO_x primarily by lowering the flame temperature and O_2 concentration to reduce the amount of thermal NO_x. The lo-NO_x burner achieves its goal by means of two stage combustion. The gas first burns in a zone low in excess oxygen. Combustion is completed at high excess air in a secondary combustion zone.

A second NO_x reduction strategy is exhaust gas recirculation (EGR) in which a portion of the exhaust gas is premixed with the fuel prior to the fuel entering the combustion chamber. The buffering effects

[1]The generic term "heater" will be used henceforth to indicate all heaters, furnaces, and boilers.

[2]Prompt NO_x is NO_x formed in low temperature flames by the action of C, CH, and CH_2 radicals on molecular nitrogen and subsequent formation of NO_x. See reference 3.

of the added exhaust moderate the flame temperature thereby preventing the copious formation of thermal NO_x.

Some heaters use both staged combustion and EGR to reduce NO_x emissions.

Operational controls used to minimize NO_x: limiting excess combustion air. The amount of excess combustion air is the single most significant operational parameter that limits NO_x production from industrial heaters. Although some excess air is necessary to ensure complete combustion, air in excess of that required for efficient combustion raises the production of thermal NO_x. Figures 1, 2, and 3 illustrate how NO_x formation depends on excess O_2.

Figure 1 shows the increasing trend of NO_x concentration (normalized to 3% oxygen) on excess air for a variety of heaters. Figure 2 clearly shows for staged (i.e. lo-NO_x) burners the importance of controlling the level of excess oxygen to reduce NO_x formation. Figure 3 shows that in methane-air flames a dramatic increase in NO_x occurs with increasing excess air. Note also that NO_x formation occurs primarily in the post flame region. Excess air should in general not be allowed to fall below about 1% since the CO level could increase many fold.

Add-on controls to minimize NO_x. Reduction of NO_x emissions by use of add-on control equipment is not commonly encountered. Selective catalytic reduction (SCR) using ammonia to reduce the NO_x to N_2 is occasionally used but no such control unit is known to be in operation in New Mexico. Use of SCR is problematic because the operator must exercise careful control of the ammonia injection rate to prevent the notorious ammonia slip problem.

Combustion Analyzers. A portable combustion analyzer may be used for monitoring flue gas from heaters. The analyzer should be capable of measuring the concentrations of NO_x, CO, and O_2. For some heaters, an O_2 sensor by itself would be sufficient.

Portable combustion analyzers range in price from about $1000 for a simple analyzer that only has an O_2 sensor to about $20,000 for a highly stable, sophisticated unit with sensors for NO_x, CO, SO_2, VOC, and O_2 as well as a pilot tube for flow measurement.

The capability to measure NO_x, CO, and O_2 is especially important for heaters that have stack test results on record and for heaters that have fuel flow meters. In the former case, the monitored values can be compared to the test results as a check on proper operation of the heater.

If a reliable fuel flow meter is in operation, the NO_x, CO, and O_2 concentration data can be combined with the fuel feed rate to obtain NO_x and CO mass emissions rates. Either F-factors or simple stoichiometric relations can be used to derive stack flow from measurements of fuel flow and excess O_2. The accuracy of these measurements is expected to be around $\pm$20% when using a properly calibrated analyzer and a properly calibrated fuel flow meter.

Stack flow can also be measured using a Pilot tube traverse in accordance with EPA Methods 1 and 2.

JUSTIFICATION
(Not for inclusion in permit)

Operational Inspections. Operational inspections are very important to ensure proper operation of the heater. These inspections were included in the monitoring since they allow the operator to determine

almost at a glance whether the heater is operating properly. The inspection is a qualitative test for the level of excess air.

Equipment Inspections. Equipment inspections ensure that repairs will be undertaken to allow the heater to operate properly. An improperly operating heater could result in excess emissions of CO.

Excess Air Checks. The direct measurement of excess air using an electronic analyzer or an ORSAT apparatus was included to ensure that the heater operates within the recommended excess air range. A lack of air causes the CO emissions to soar while too much air causes the NO_x to soar.

Mass Emissions Tests. These tests were included for the larger heaters to ensure that they operate within the permitted limits.

EPA Methods Test. To ensure compliance with CO and NO_x limits, all heaters with a P.E.R. greater than 25 TPY NO_x or CO will need to undergo a full EPA set of tests if no test has been carried out within the previous ten years.

REFERENCES

1. Student Manual, APTI Course 427, Combustion Evaluation, EPA 450/2-80-063, February 1980, primarily Chapter 7 (Gaseous Fuel Burning); and Chapter 16 (NO_x Control).

2. Energy, Combustion, and Environment, Norman Chigier, McGraw Hill, 1981, primarily Chapter 8, Formation and Control of Pollution in Flames.

3. Air Pollution Control Engineering, Noel De Nevers, McGraw Hill, 1995, primarily Chapter 12 (Control of Nitrogen Oxides).